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PROGRESS REPORT

TESTS TO CONTROL THE LODGEPOLE NEEDLE MINER IN YOSEMITE NATIONAL PARK, SEASON OF 195~~9~~8

By

Galen C. Trostle and Robert E. Stevens, Entomologists

NOT FOR PUBLICATION

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE
PACIFIC SOUTHWEST FOREST AND RANGE EXPERIMENT STATION

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Division of Forest Insect Research

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INTRODUCTION

Field tests to control the lodgepole needle miner during the current outbreak in Yosemite National Park have been underway since 1955. 1/ While aerial spray techniques for controlling the moths and newly hatched larvae have been reasonably successful, the timing of the spray against these forms is very critical. It would be desirable to be able to kill the larvae while they feed within the needles, as they remain in this site for about 21 months.

To this end, two helicopter spray tests were conducted in 1958, one each in the spring and the fall. Also in 1958 two related surveys were made, one to determine needle miner survival after spraying at two different heights in the tree crown, and another to determine the reduction in damage on plots sprayed in 1957 and 1958. Results of all these investigations are included in this report.

The work was carried out by G. C. Trostle, who was aided by summer assistant Robert L. Rennie.

SPRING 1958 SPRAY TEST

Purpose

The test conducted in the spring of 1958 was designed to evaluate a helicopter application of malathion against larvae that had just passed their first winter within the needles. The treatment consisted of 0.1 pound of malathion in 1 gallon of fuel oil, applied at the rate of 20 gallons per acre to a single 100-acre plot.

Plot Layout

The test plot was located on the south side of Delaney Creek (fig. 1). The stand on the southeast edge of this plot is primarily dense young growth, overtopped by snags. In the remainder of the plot the stand is old, open and park-like. The boundaries of the plot, 20 by 50

1/ Trostle, Galen C. and Charles B. Eaton, 1958. Progress report, tests with insecticides to control the lodgepole needle miner, 1956 and 1957 seasons. U. S. Forest Serv.; Calif. Forest and Range Expt. Sta., Berkeley, 22 pp., illus. (Processed).

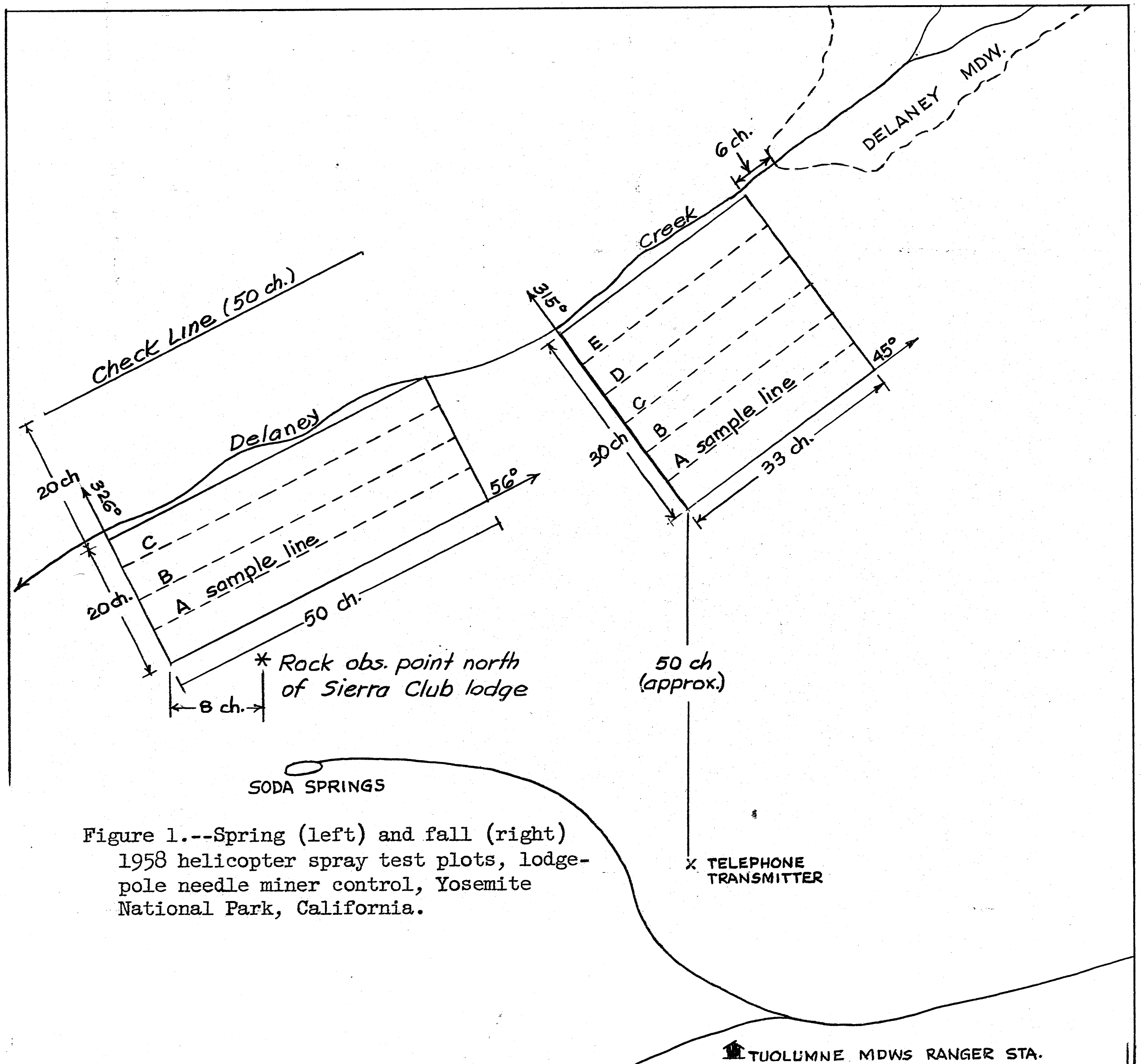

Figure 1.--Spring (left) and fall (right) 1958 helicopter spray test plots, lodgepole needle miner control, Yosemite National Park, California.

chains, were established by compass and pacing. The corners were marked with white butcher paper and butcher paper was also placed on the ground at 10-chain intervals to mark the boundaries. These markers were primarily of value in orienting the pilot of the aircraft on the location of the plot. During actual spraying 3-foot by 4-foot targets, made of hardboard covered with aluminum foil, were used as reflectors to help show the pilot the beginning and end of each spray run.

Three lines of sample trees, A, B, and C, were laid out lengthwise of the plot. Lines A and C were each 5 chains in from the sides of the plot, and line B was midway between them. The sample trees on each line were spaced at about 1.5-chain intervals; altogether there were 100 sample trees. An additional 100 trees were also selected in the untreated area outside the plot (fig. 1). These served as the control for both the spring and the fall tests of this year.

Equipment

A Bell G-2 helicopter was used to apply the spray. It was fitted with a 24-foot boom carrying 11 Spraying Systems Company "Teejet" nozzles with D-7 orifices, and 12 nozzles with D-5 orifices, each with #46 discs. The load carried was 25 gallons. The system was calibrated to deliver the entire 25-gallon load in one spray run the length of the plot. The helicopter was operated at a speed of 20 miles per hour (m.p.h.), and at a height of 100 feet or less above the treetops during spraying. The nominal swath width was $16\frac{1}{2}$ feet.

Spray Operations

Spraying began on June 21 and was completed on June 24. Daily operations began at 5:00 a.m. and were concluded at around 9:30 a.m., when wind or rising temperatures made conditions unsatisfactory. Each trip averaged 9 minutes long, including 45 seconds to load the spray and 40 seconds actual spraying time. The rest of the time was ferry time. For reasons that can only be surmised, the total volume of spray which was to be applied (2,000 gallons) was short by 200 gallons. This shortage affected only a 2-chain strip along the southeast side of the plot, and probably had no effect on needle miner mortality in the sample trees nearest this side, since they were 2.5 chains away.

Precautions taken to insure that the proper amount of insecticide was applied included a laboratory analysis of the spray, (by an outside agency) to insure compliance with the specified malathion content, and a daily spray coverage check through the use of oil-sensitive cards. The cards were set out each morning before spraying and picked up when the day's operations were over. Droplet size and distribution, as indicated by the oil-sensitive cards, appeared to be satisfactory.

Measuring the Effects of the Spray

To determine the effects of the spray on the needle miner, samples of the foliage were taken from all sample trees on the treated and untreated areas just before spraying, 2 days after spraying, and 2 weeks after spraying. At each sampling, two twig tips were taken with pole pruners from each tree, at a height of about 18 feet. The tips were transported to the laboratory and the number of live larvae per sample of 10 mined needles (pulled at random from the last 2 whorls of needles) was counted under a microscope. From every third tree, an extra sample was taken for larval development observations.

Results

The data showing the effects of the spray on needle miner larvae in this test are summarized in table 1. Larval mortality apart from that due to natural factors, as computed by Abbott's formula, took place mostly within 2 days after spraying; but by the end of two weeks it was only 45 percent. The larvae were generally in the first instar when the spraying took place. By the time the final mortality count was made, most were in the second instar. A few were in the third.

Table 1.--Control of early instar lodgepole needle miner larvae on a 100-acre test plot sprayed with malathion, June 1958 1/

	Untreated			Treated		
	Pre-spray	Post-spray 2 days	Post-spray 14 days	Pre-spray	Post-spray 2 days	Post-spray 14 days
Number tips samples	200	200	200	200	200	200
Number live larvae per sample-						
mean	7.22	7.56	7.64	6.26	4.50	3.64
S.E.	±0.12	±0.54	±0.12	±0.12	±0.69	±0.15
Percent control					31.4	45.0

1/ 0.1 lb. malathion per gal. diesel oil; dosage 20 gals. per acre.

FALL 1958 SPRAY TEST

Purpose

The test staged in the fall of 1958 was designed like the spring test and had the same purpose; but it was aimed at more mature larvae. The same insecticide formulation, 0.1 pound of malathion in 1 gallon of oil fuel, was used and the application rate, 20 gallons per acre, was the same.

Plot Layout

Another 100-acre spray plot, this one 30 by 33.3 chains, was laid out farther up Dingley Creek, to the northeast of the spring plot (fig. 1). The stand here is predominantly old-growth, large diameter trees, many over 30 inches in diameter at breast height.

The corners and centers of the boundaries of the plot were marked with cotton sheets having a red stripe down the center. Reflector boards were again used to help guide the pilot on spray flights.

Five lines of sample trees were laid out on this plot, the lines being spaced 5 chains apart as shown in figure 1. Twenty trees were selected along each line, beginning 7 chains in from the southwest edge of the plot, and taken at 1-chain intervals thereafter, making a total of 100 trees. As noted previously, the control trees in this test were the same ones sampled in the spring test.

Equipment

An Alouette helicopter (fig. 2) was used for the spraying done in this test. It was equipped with a 24-foot spray boom carrying 36 Teejet nozzles. The nozzles were directed straight downward, and each produced

Figure 2.--Alouette helicopter used in fall 1958 needle miner spray test.

an 80° fan of spray from a 2.0 mm. orifice. An electric pump providing a pressure of 40 pounds per square inch was used to discharge the spray. The load carried was 50 gallons. The system was calibrated to deliver this load in two spray flights lengthwise of the plot. The helicopter was operated at 45 m.p.h., and at a height of 100 feet or less above the tree canopy. The calculated swath width was 25 feet.

Spray Operations

The test plot was sprayed on September 30 and October 1. All but 100 gallons were put on the second day, September 30 being excessively windy. Part of sample line A was missed, and because of this it was subsequently excluded from mortality calculations. As before, oil-sensitive cards were used to check spray coverage, and again, droplet size and distribution appeared to be satisfactory.

Measuring the Effects of the Spray

Sampling to determine the degree of needle miner control in this test was done similarly to that in the spring test, except for one difference. Late-instar larvae are more sensitive to handling, and tend to abandon the needles in which they are feeding within 10 minutes of the time the tips are cut; because of this, the population was determined in the field at the time the samples were taken. The samples again consisted of 10 mined needles per tip collected at random. Jeweler's eye loupes were used as an aid in determining the condition of the larvae, i.e. whether they were alive or not. The precontrol sampling was done just prior to spraying, and the postcontrol sampling, which was done only once this time, was 2 weeks later (October 15 and 16).

Results

The data on needle miner larval mortality in this test are summarized in table 2. The mortality from the spray application, corrected by Abbott's formula for natural mortality, averaged 77 percent.

Table 2.--Control of late-instar lodgepole needle miner larvae on 100-acre test plot sprayed with malathion in October 1958 1/

	Untreated		Treated	
	Prespray	Postspray	Prespray	Postspray
Number tips sampled	200	200	160	160
Number live larvae per sample				
mean	8.13	6.90	8.31	1.62
S.E.	±0.10	±0.13	±0.13	±0.15
Percent control				77.0

1/ 0.1 lb. malathion per gal. diesel oil; dosage 20 gals. per acre.

The results of the spraying done in the spring of 1958 show fairly conclusively that the malathion spray formulation used is not satisfactory for controlling the early instar needle miner larvae. On the other hand, the results of the fall test, against the more fully developed larvae, were about as successful as the best of previous trials with this insecticide against the moths and newly hatched larvae. However, by the time the larvae are reaching maturity most of the damage has been done. To prevent this damage, the insect must be controlled before it reaches this stage.

SAMPLING HEIGHT

Purpose

There has always been some question about how well needle miner population samples, taken at the 15 to 20 foot sampling height commonly used in this work, represent conditions higher in the crown of the tree. This height has been used largely because of expediency. The pole pruners used to clip off the tips of the twigs are made up of a cutting head (#10 Trimmer, J. B. Sebrell Corp.) and aluminum extensions, the latter in multiples of 6 feet. With two extensions, samples can be taken easily at the 15-20 foot level, and collections can be made with a minimum of effort and maximum of speed. Up to this year, however, it had not been determined if, after spraying, larval survival at this height was comparable to that in the upper crown. To provide information on this point, a special study was conducted.

Methods

On July 29 and 30, a series of samples were collected from trees within the unsprayed plot and the plot sprayed in June this year. The heights sampled were 15-20 feet and 30-35 feet. Two tips from each height were cut from 28 trees in the sprayed plot, and from 30 trees in the unsprayed. Samples of 10 mined needles were pulled at random from each tip, and the number of live larvae recorded. The sample trees in each plot were all located within a one-acre area to minimize physical difficulties in collecting the material.

For the lower height, the usual pole pruner assembly was used. Together these three units provided a total pruner length of around 14 feet, which is easily manageable. To reach the higher level, three additional 6-foot sections were added to the assembly, making the pruner about 32 feet long. This was the maximum length that could safely be moved from tree to tree without dismantling. Even so it was awkward to use, and slowed down the sampling job considerably.

Results

The data from this test are summarized in table 3. They show a 36.5 percent difference in larval survival at the two heights sampled in

the sprayed area, and an 8.2 percent difference in the unsprayed area. This means that sampling at the lower height gives quite conservative estimates of the effectiveness of spraying, and that spraying produces a greater kill in the tops of the trees than in their lower portions.

Table 3.--Lodgepole needle miner population in different parts of the crown on treated and untreated areas

Treatment	Number tips sampled	No. live larvae per sample: 30-35 ft.		No. live larvae per sample: 15-20 ft.		Difference 1/
		Mean	SE	Mean	SE	Percent
Sprayed	55	1.60	± 0.22	2.52	± 0.16	36.5
Unsprayed	59	7.75	± 0.19	8.44	± 0.13	8.2

1/ Computed as a percentage of the population at the 15 to 20 foot level.

EFFECTS OF SPRAY IN REDUCING DAMAGE

Purpose

With the completion of the October 1958 test, control of the needle miner with malathion applied by helicopter had been tried at four different periods in the insect's development within a 2-year span. Spraying had been done against (1) moths, (2) larvae emerging from the eggs, (3) overwintered first-instar larvae, and (4) late-instar larvae.

In all of these tests, the measure of control was the degree of reduction in needle miner population due to spraying. It was not known whether defoliation would be reduced correspondingly. And in the case of the moth test a real possibility for the effects of spraying to be obliterated existed. The plots were small and the effects of spraying could have been masked by migrating moths of the same generation from the surrounding untreated area. To provide some idea of the relationship between reductions in needle miner population immediately after spraying, and later reductions in damage, data on defoliation were collected in the fall of 1958.

Methods

The plots from which the data for this study were collected were the ones which had been sprayed in 1957, 2/ and in the spring of 1958.

2/ Trostle and Eaton, op. cit.

The fall 1958 plot was omitted because by September 28 and 29, when the samples were taken, it had not been treated.

The samples consisted of two tips each from the midcrown of varying numbers of trees in the sprayed and appropriate unsprayed areas. All the mined needles in the 1958 whorl were counted on each tip, and on every fifth tip all the green needles were counted also. The difference in the average number of mined needles between the sprayed and unsprayed trees was assumed to be due to the treatment. The comparability of the needle miner populations in the different areas before treatment is reflected in the prespray population counts made for each test. 3/ The number of mined needles before spraying was not determined in any of the tests, so that the prespray needle miner counts provide the only index of comparability for the different areas.

Results

The data obtained in this study are summarized in table 4. They show that the needle miner population reductions which resulted from the malathion soon after spraying was done, were in every case followed by reductions in defoliation. For example, in the 20 gallon per acre test against the moths, staged in July 1957, malathion reduced the needle miner population by 74.8 percent. In September the following year, when the mined needle samples were taken, the reduction in defoliation was 64.8 percent. Poor needle miner kill gave correspondingly poor results in reducing damage.

3/ See tables 1 and 2 above; also Trostle and Eaton, *op. cit.* pp. 17, 20.

Table 4.--Effects of malathion in reducing needle miner populations and later defoliation on plots sprayed in 1957 and 1958

Stage of development	Period sprayed	Treatment 1/	Area sprayed	Number tips sampled	Needles per tip in '58 whorl: Green Mean	Green SE	Mined Mean	Mined SE	Reduction: Mined needles 2/	Reduction: Needle miners 3/
		Gals./acre	Acres		Mean	SE	Mean	SE	Percent	Percent
Moth	July 1957	10	20	96	63 ±	6	18.5 ±	1.7	38.5	67.6
		0	-	94	59 ±	6	30.1 ±	1.8		
Moth	July 1957	20	20	99	59 ±	4	10.5 ±	0.9	64.8	74.8
		0	-	92	65 ±	5	29.8 ±	1.6		
Newly hatched larva	Sept. 1957	20	40	100	82 ±	16	8.7 ±	1.0	79.4	
		0	-	50	96 ±	12	42.2 ±	2.9		
Newly hatched larva	Sept. 1957	20	90	99	53 ±	7	4.8 ±	0.7	69.0	
		0	-	99	68 ±	10	15.5 ±	1.2		4/ 72.3
Newly hatched larva	Sept. 1957	20	200	135	79 ±	5	11.2 ±	0.8	65.2	
		0	-	135	75 ±	5	32.2 ±	1.6		
Overwintered 1st instar	June 1958	20	100	196	43 ±	4	9.1 ±	0.2	10.3	45.0
		0	-	393	31 ±	2	10.5 ±	0.3		

1/ 0.1 lb. malathion per gal. diesel oil.

2/ Reduction in defoliation by September 1958. Difference between sprayed and unsprayed expressed as a percent of unsprayed.

3/ Population reduction immediately after spraying (sources: table 1 above; and Trostle and Eaton, op. cit., pp. 17, 20).

4/ Computed from pooled data for all three plots treated in September, 1957.